

(12) UK Patent Application (19) GB (11) 2 353 564 (13) A

(43) Date of A Publication 28.02.2001

(21) Application No 0019914.1

(22) Date of Filing 15.08.2000

(30) Priority Data

(31) 19940290

(32) 25.08.1999

(33) DE

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(51) INT CL⁷

F02M 47/02

(52) UK CL (Edition S)

F1B B2JCB B2JCN B2JCP B2J15A2 B2J15B2 B2J15C
B2J15E

(56) Documents Cited

WO 99/01660 A1

(58) Field of Search

UK CL (Edition R) F1B B2JCB

INT CL⁷ F02M 47/02

online: EPODOC, JAPIO, WPI

(54) Abstract Title

Control valve for a fuel injection valve

(57) The control valve comprises a valve needle 28 which can be displaced in a control chamber 22, and a control pressure space 16 having an inlet 18 and an outlet 42, 44, 50. A valve seat 44 for a throttle element 40 is formed in the control pressure space 16, the throttle element 40 having a throttle bore 50 and being urged by a spring 48 against the valve seat 44. A closure element 54;60 at least partially closes the inlet 18 when the throttle element 40 is raised from the valve seat 44. The closure element 54 can be formed by a control edge of the throttle element 40, fig.3, or by a valve ball 60, fig.4. In operation, when the valve needle 28 is displaced only slightly into control chamber 22, the outlet from the control pressure space 16 is restricted by throttle bore 50, leading to a small displacement of actuating part 14 and hence of nozzle needle (12, fig.1) so that a pre-injection is achieved. When valve needle 28 is displaced further, it presses the throttle element 40 into the control pressure space 16 thus not only reducing the inlet 18 but also increasing the outlet; a rapid fall in pressure in the control space 16 thus occurs which is advantageous for the main injection.

FIG. 3

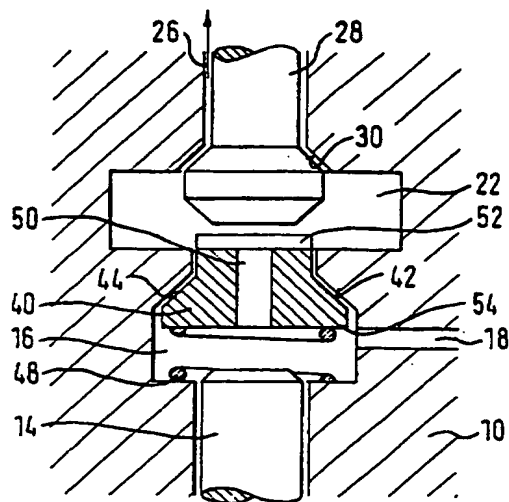
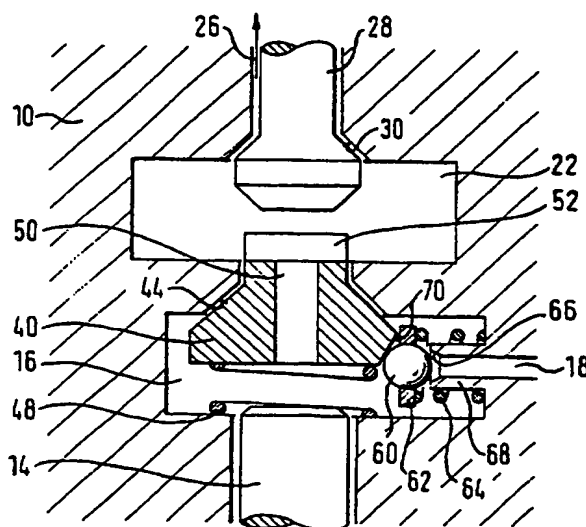


FIG. 4



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FIG. 2

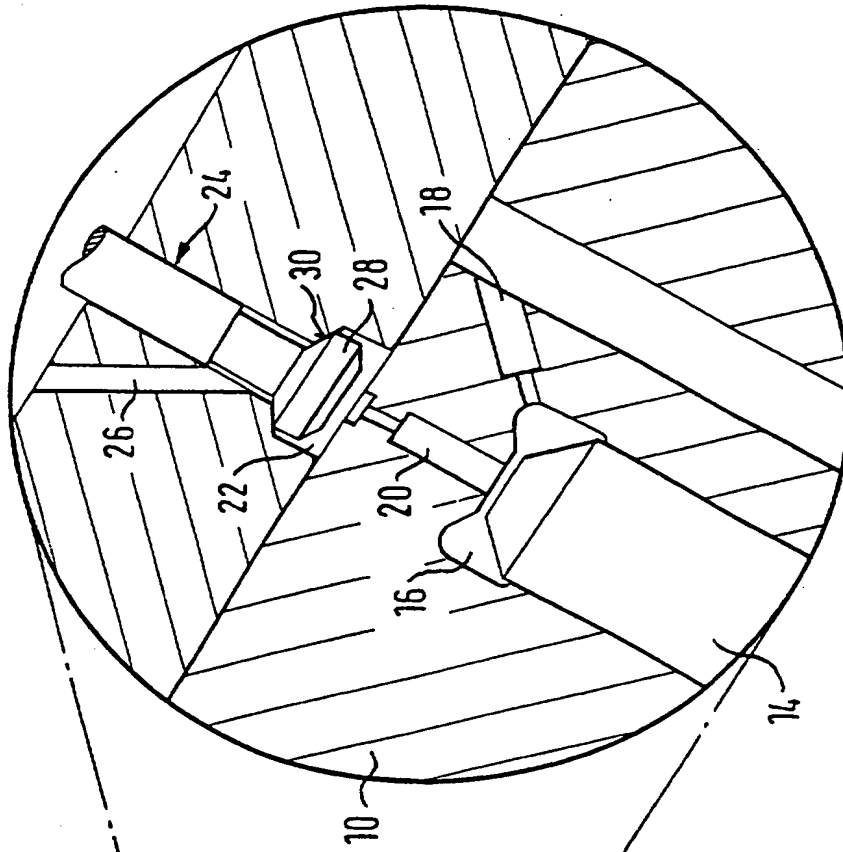
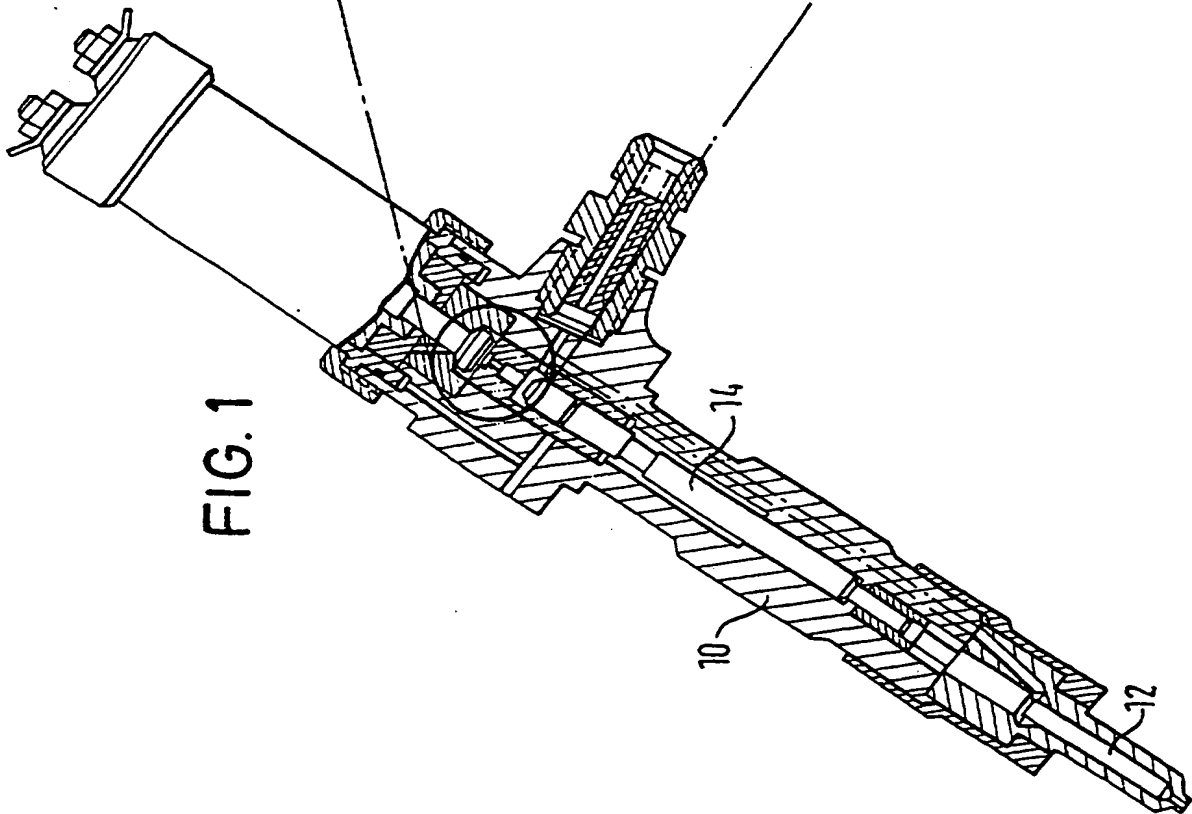


FIG. 1



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FIG. 3

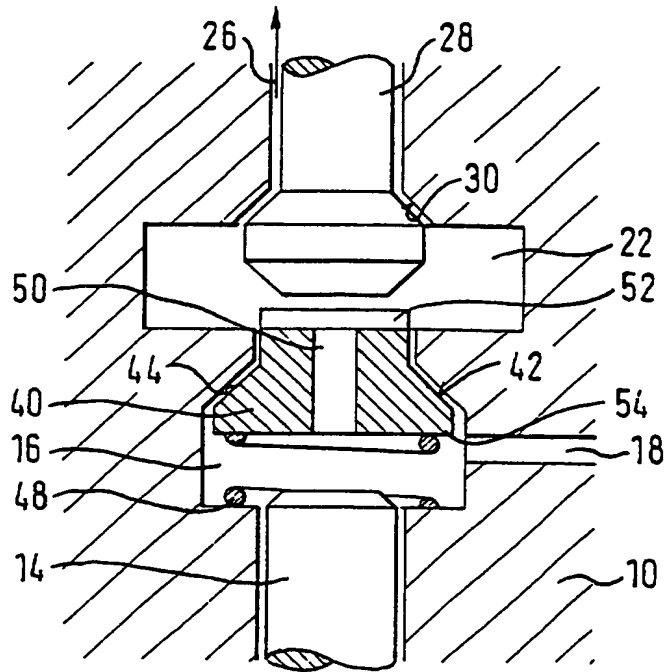
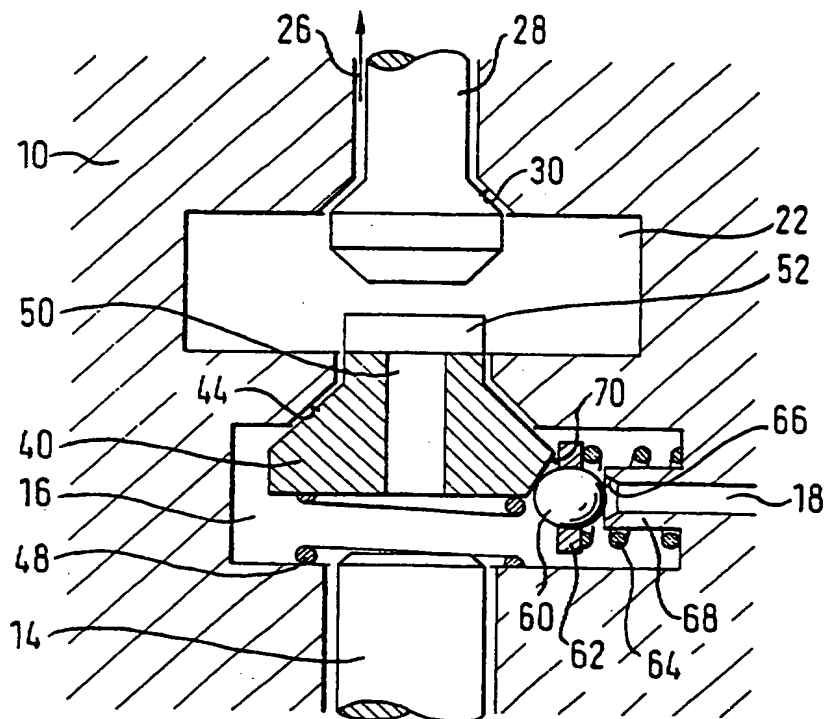


FIG. 4



DESCRIPTIONCONTROL VALVE FOR A FUEL INJECTION VALVE

The invention relates to a control valve for a fuel injection valve having a valve needle which can be displaced in a control chamber, and having a control pressure space which is provided with an inlet and an outlet.

A control valve of this type is known, for example, from DE 197 27 896 A1 and serves to cause a nozzle needle of an injection valve to open in order to inject fuel into a cylinder of an internal combustion engine.

The nozzle needle is permanently acted upon by an opening pressure which attempts to lift the nozzle needle from the associated valve seat. A closing force, which is produced in the control pressure space, acts against this opening force. Provided that the pressure in the control pressure space is kept at a high level, the closing force produced therein is higher than the opening force acting upon the nozzle needle so that the nozzle needle remains closed. If, in contrast, the pressure in the control pressure space, and consequently also the closing force produced therein, falls, the opening force is able to raise the nozzle needle from the valve seat. Fuel can then be injected.

The pressure in the control pressure space is controlled by the control valve, in that an outlet is closed or opened. If, as a result of the closure of the

outlet, the medium supplied to the control pressure space, normally fuel, is banked up, a high pressure is produced in the control pressure space and holds the nozzle needle in the closed condition. If, in contrast, the control valve opens the outlet, the pressure in the control pressure space falls so that the nozzle needle can open.

In accordance with the present invention there is provided a control valve for a fuel injection valve having a valve needle which can be displaced in a control chamber, and having a control pressure space which is provided with an inlet and an outlet, wherein a valve seat for a throttle element is formed in the control pressure space, which throttle element has a throttle bore and is urged by a spring element against the valve seat, and further including a closure element which, when the throttle element is raised from the valve seat, at least partially closes the inlet.

Such a control valve has the advantage that increased speed of the nozzle needle during opening and closing can be obtained. This is derived from the fact that by raising the throttle element from the valve seat a comparatively large outlet cross-section can be produced which leads to a rapid fall in pressure in the control volume and to a high needle speed. At the same time, the cross-section of the inlet to the control pressure space is reduced, which assists the drop in pressure in the control pressure space. A further advantage consists of the fact that the pre-injection and main injection can be adjusted more precisely since the outlet cross-section pertinent to the pre-injection, namely the diameter of the throttle bore, can be set independently of the outlet cross-section determining the main injection,

namely the diameter of the valve seat. A further advantage is a reduction in the number of rejections during manufacture since the throttle element for the outlet can be produced independently of a throttle element disposed in the inlet. Furthermore, the two throttles can be better matched experimentally since they consist of two separate components.

In accordance with a preferred embodiment of the invention, provision is made that the closure element is formed from a control edge of the throttle element. In this way it is directly possible, without interpositioning of additional elements, to obtain a reduction in the inlet cross-section when the throttle element is raised from the valve seat.

In accordance with an alternative embodiment, provision is made that the closure element is formed by a valve ball and that the throttle element is provided with an inclined surface which can actuate the valve ball. This embodiment has the advantage that by means of the tilt of the inclined surface it is possible to adjust the switching behaviour of the valve ball as desired.

The invention is described hereinafter, by way of example only, with the aid of two exemplified embodiments which are illustrated in the attached drawings, in which:

- Figure 1 is a schematic view of a fuel injection valve;
- Figure 2 is an enlarged view of a control valve in accordance with the prior art,

which can be used in the fuel injection valve of Figure 1;

- Figure 3 is a cross-sectional view of a control valve in accordance with the invention, having a control pressure space in accordance with a first embodiment; and

- Figure 4 is a cross-sectional view of a control valve in accordance with the invention, having a control pressure space in accordance with a second embodiment.

Figure 1 shows a conventional fuel injection valve with a control valve (see Figure 2). The fuel injection valve comprises a valve body 10 in which a nozzle needle 12 is displaceably housed. The nozzle needle 12 controls the injection of the fuel into a cylinder of an internal combustion engine (not shown). The fuel taken in exerts an opening force on the nozzle needle 12, which force attempts to displace the nozzle needle and an actuating part 14, against which the nozzle needle 12 abuts, towards a control pressure space 16.

Fuel is also supplied to the control pressure space 16 and, by reason of the pressure prevailing in the control pressure space 16, exerts a closing force on the actuating part 14. The fuel is provided via an inlet 18, and an outlet 20 issues from the control pressure space 16 and leads to a control chamber 22 of a control valve 24. The outlet 20 in turn constitutes the inlet for the control valve 24 and an

outlet 26 is provided through which the fuel can flow out from the control pressure space 16 and the control chamber 22.

The control valve 24 comprises a valve needle 28 in the control chamber 22, which needle cooperates with a valve seat 30. When the valve needle 28 lies against the valve seat 30, the control valve 24 is closed so that the fuel supplied via the inlet 18 to the control pressure space 16 is banked up therein. The high pressure thus produced exerts a closing force on the actuating part 14, which force is greater than the opening force acting upon the nozzle needle 12. The fuel injection valve is consequently closed. If, in contrast, the valve needle 28 is lifted from the valve seat 30 the fuel can flow out from the control pressure space 16 via the control chamber 22 and the outlet 26 so that the pressure in the control pressure space falls. The then-reduced closing force makes it possible for the nozzle needle to open so that fuel is injected.

A control valve in accordance with the present invention is described hereinafter with the aid of Figure 3, having a control pressure space according to a first embodiment. A throttle element 40 is disposed in the control pressure space 16 and is provided with a frusto-conical-shaped sealing surface 42 which cooperates with a frusto-conical-shaped valve seat 44. A compression spring 48 is disposed in the control pressure space 16 and acts upon the throttle element 40 in position on the valve seat 44. A throttle bore 50 is formed in the throttle element 40 and is a part of the outlet of the control pressure space 16. On the side facing away from the actuating part 14, the throttle element 40 is provided with a groove

52 which is connected to the throttle bore 50.

The throttle element 40 is also provided with a closure element 54 which is formed as a control edge and can close the inlet 18 to the control pressure space 16. When the closure element 54 is formed as a projection on one side of the throttle element, it is also necessary to provide a securement against rotation, which ensures that the control edge lies precisely opposite the inlet 18. When the throttle element, in contrast, is formed as a rotationally symmetrical part, it is possible to omit the securement against rotation. However, the whole outer periphery must then be precisely worked so that it can act as a control edge.

The control valve cooperates with the throttle element in the following manner: When the valve needle 28 is displaced only slightly into the control chamber 22, so that it does not lie against the throttle element 40, an outlet from the control pressure space 16 through the throttle bore 50 and the valve seat 30 is opened, which has a comparatively small cross-section. This cross-section is determined in particular by the cross-section of the throttle bore 50. The fall in pressure in the control pressure space caused with this small outlet cross-section leads to a small displacement of the actuating part 14 and of the nozzle needle 12 so that a pre-injection is achieved.

When the valve needle 28 is displaced further in the direction towards the actuating part 14, it lies at the upper end, with respect to Figure 3, of the throttle element 40 and presses this throttle element into the control pressure space 16. At the same time as the raising of the throttle element 40 from the valve seat 44, the

control edge formed on the throttle element closes the inlet 18 at least partially. Now, with a reduced inlet, a large outlet to the control chamber is released, namely both by way of the throttle bore 50 and the groove 52 as well as between the valve seat 44 and the valve surface 42. By reason of the reduced inlet and enlarged outlet, a rapid fall in pressure in the control pressure space takes place, which leads to a high nozzle needle speed. This is advantageous for the main injection.

Figure 4 shows an alternative embodiment. In contrast to the embodiment according to Figure 3, a valve ball 60 is used in this case to close the inlet 18. This is held in a holding device 62 and urged towards the throttle element 40 by a compression spring 64. The inlet 18 is in this case formed with a valve seat 66 which is formed on the end face of a cylindrical projection 68. The projection 68 serves at the same time to fix the spring 64.

An inclined surface 70 is formed on the throttle element 40 and cooperates with the valve ball 60. This inclined surface 70 is inclined in such a way that the switching process of the ball 60 can be adjusted appropriately in dependence upon the displacement of the throttle element 40 inside the control pressure space 16.

The operation of the throttle element according to the second embodiment corresponds to that of the throttle element of the first embodiment. In a first switching condition only the valve needle 28 is raised from the valve seat 30, whereas the throttle element 40 continues to lie against the valve seat 44. The inlet 18 therefore remains unchanged and the outflow of the fuel from the control

control edge formed on the throttle element closes the inlet 18 at least partially. Now, with a reduced inlet, a large outlet to the control chamber is released, namely both by way of the throttle bore 50 and the groove 52 as well as between the valve seat 44 and the valve surface 42. By reason of the reduced inlet and enlarged outlet, a rapid fall in pressure in the control pressure space takes place, which leads to a high nozzle needle speed. This is advantageous for the main injection.

Figure 4 shows an alternative embodiment. In contrast to the embodiment according to Figure 3, a valve ball 60 is used in this case to close the inlet 18. This is held in a holding device 62 and urged towards the throttle element 40 by a compression spring 64. The inlet 18 is in this case formed with a valve seat 66 which is formed on the end face of a cylindrical projection 68. The projection 68 serves at the same time to fix the spring 64.

An inclined surface 70 is formed on the throttle element 40 and cooperates with the valve ball 60. This inclined surface 70 is inclined in such a way that the switching process of the ball 60 can be adjusted appropriately in dependence upon the displacement of the throttle element 40 inside the control pressure space 16.

The operation of the throttle element according to the second embodiment corresponds to that of the throttle element of the first embodiment. In a first switching condition only the valve needle 28 is raised from the valve seat 30, whereas the throttle element 40 continues to lie against the valve seat 44. The inlet 18 therefore remains unchanged and the outflow of the fuel from the control

pressure space 16 is determined solely by the cross-section of the throttle bore 50. In a second state in which the valve needle 28 is displaced to such an extent that the throttle element 40 is also lifted from its seat, it is the case, on the one hand, by reason of the cooperation of the inclined surface 70, the valve ball 60 and the valve seat 66, that the cross-section of the inlet 18 is reduced or completely closed. On the other hand, by reason of the raising of the throttle element 40 from the valve seat 44, a further outlet cross-section in addition to that of the throttle bore 50 is produced.

CLAIMS

1. A control valve for a fuel injection valve comprising a valve needle which can be displaced in a control chamber, a control pressure space having an inlet and an outlet, a valve seat for a throttle element in the control pressure space, which throttle element has a throttle bore and is urged by a spring element against the valve seat, and a closure element which, when the throttle element is raised from the valve seat, at least partially closes the inlet.

2. A control valve as claimed in claim 1, wherein the closure element is formed by a control edge of the throttle element.

3. A control valve as claimed in claim 1, wherein the closure element is formed by a valve ball and that the throttle element has an inclined surface by which the valve ball can be activated.

4. A control valve for a fuel injection valve, substantially as hereinbefore described, with reference to and as illustrated in Figures 3 and 4 of the accompanying drawings.



Application No: GB 0019914.1
Claims searched: 1 to 4

Examiner: John Twin
Date of search: 7 November 2000

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.R): F1B (B2JCB)

Int CI (Ed.7): F02M 47/02

Other: online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	WO 99/01660 A1 (Robert Bosch)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.